

ATTACHMENT 19
SAMPLING AND ANALYSIS PLANS

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1.0 BASELINE SAMPLING DATA

1.1 SUMMARY OF EXISTING SAMPLING DATA

The U.S. Army Environmental Hygiene Agency (AEHA) conducted an investigation at the Tooele Army Depot (TEAD) Open Burning/Open Detonation (OB/OD) Unit between 1981 and 1985. This investigation was one of many conducted at OB/OD sites nationwide to evaluate the potential for environmental contamination. The investigation at TEAD focused on the burn pad area and trash burn pits located to the east of the active OB/OD Unit and on the cluster bomb area located to the northwest. Sampling and analysis were conducted in two phases. No samples were collected from the OD pits due to the possibility of buried ordnance. Surface and subsurface soil samples were analyzed for six energetic compounds (RDX, HMX, TNT, tetryl, 2,6-DNT, and 2,4-DNT), reactivity, RCRA metals, and extraction procedure (EP) toxicity for eight RCRA metals. Energetics were detected in trace concentrations in 38% of the samples taken from the top 18 in. of soil. No energetics were detected in samples at greater depths. All EP toxicity metals results were below detection limits (AEHA, 1985).

In 1992 a Phase I RCRA Facility Investigation (RFI) was conducted at the TEAD OB/OD Unit. The following is a brief summary of the investigation:

- Eighty-two test pits were completed in the Main Demolition Area. Two soil samples were collected from each test pit. Buried metallic debris was observed in some test pits. Samples were analyzed for 23 metals, cyanide, energetics, and specific anions. A limited number of soil samples were also analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), dioxins/furans, and explosive reactivity. Results indicated elevated levels of metals. Minor levels of VOCs and SVOCs were detected in samples collected from outside the active OB/OD Unit. VOCs detected include acetone, xylene, ethylbenzene, and toluene. Only three SVOCs were detected at levels greater than 10² g/g. These compounds include 2-(1-methylethyl)naphthalene, heneicosane, and phenanthrene. Energetic compounds detected included 2,4,6-TNT; 1,3,5-TNB; RDX; HMX; 2,6-DNT; and NB. Three soil borings were completed to depths of 100 feet bgs, and seven subsurface soil samples were taken from each boring. Phase I results indicated that contamination does not exist in soil samples deeper than 10 feet bgs.
- Seven test pits were completed within the OB area boundary. Soil samples were collected from pits and analyzed for metals, cyanide, and explosive compounds. Only surface soils showed elevated levels of metals compared to background. No VOCs or SVOCs were detected in soil samples taken from the OB area. Explosive compounds detected include 2,4-DNT; 2,6-DNT; and RDX.
- Sediment samples were collected from the nearest drainage ditch (Box Elder Wash) upstream and downstream of the OB/OD Unit. Results did not indicate contaminants were migrating from the unit via the surface water pathway.
- Groundwater monitoring was not conducted at the OB/OD Unit during the RFI. Groundwater was assumed to be greater than 700 feet bgs in the vicinity of the OB/OD Unit.

A follow-up Phase II was conducted in 1994. A summary of metals detected is presented in Table 1.1. Antimony, arsenic, chromium, mercury, selenium, and thallium were detected at depths greater than 10 feet.

Table 1.1. Summary of metals above background (mg/kg) for soil borings at SWMU 1 - main demolition area (RFI phase II results)

Metals Analyte	Soil borings				Background	
	SB-01-001	SB-01-002	SB-01-003	SB-01-004	HCD ^a	RGF ^b
Antimony	--	11.7 (100')	--	--	<7.14	<0.3-<7.14
Arsenic	--	18.0 (35')	--	--	3.22-6.86	<2.5-8.8
Chromium	--	27.4 (90')	--	--	<4.05-19.5	4.15-13.5
Mercury	.0589 (20') .0617 (75')	.098 (5') .0585 (15') .0677 (35')	--	.064 (100')	<.026-<.05	<0.26-0.57
Selenium	8.52 (80')	--	.885 (5') .454 (15') .492 (25') 1.13 (35') .908 (45') 1.06 (70') 1.37 (100')	1.19 (5') .598 (10') .766 (15') .621 (20') .693 (40') 1.56 (50') 1.23 (100')	<.25	<.25-.198
Thallium	--	--	--	10.2 (50')	<6.62	<6.62-13.9

^aHiko Peak soils

^bBerent-Hiko Peak soils

Thallium is not a typical component of munitions, ordnance, and propellants. Therefore, this contaminant is not associated with OB/OD operations at TEAD. Antimony, arsenic, mercury, and chromium are potential constituents of energetic materials items but are present only in trace amounts. The soil boring results for these contaminants can be characterized as spurious. The boring results do not show a consistent pattern of migration from the surface soil to the subsurface. Also, the presence of these metals at the reported depths is not consistent with their expected slow infiltration rate. Similarly, the detection of selenium at a depth of 100 feet does not coincide with the expected migration duration of thousands of years (U.S. Army, 1997b). Thus, the soil boring data for metals may be attributed to past site practices that involved burial/disposal trenches. However, a more likely explanation for these subsurface metals is the potential for alluvial deposits, considering the geologic history of the area and the natural presence of subsurface minerals (as indicated by local mining operations).

Confirmation or delineation of these past waste disposal units is not included as an objective of this environmental baseline study. The primary objective of the baseline investigation is to gather data associated with the active OB/OD Unit, while characterization of the past waste

sources is being conducted as part of the ongoing RFI at SWMU 1. However, RFI data were used (as available) to supplement or guide this investigation.

The RFI at the OB/OD Unit focused on areas of possible contamination associated with past burning in open trenches. Most sample locations were selected based on analysis of aerial photographs and visual observations of contamination. The RFI data were the result of a biased sampling approach and may be more representative of maximum contaminant concentrations. The objective of the baseline environmental sampling study is to determine the mean contaminant concentrations in surface soils over the entire OB/OD Unit. Additional study objectives were to determine if contaminants are migrating from the site via the surface water pathway and to determine the presence or absence of contaminants in subsurface soils and groundwater beneath the unit.

Although the active OB/OD Unit was the primary focus of this investigation, a background area and boundary zone area provided supplemental soil data for comparison and modeling purposes. Locations for the three study areas are shown in Fig. 1.1.

1.2 FIELD ACTIVITIES

The baseline site investigation for the OB/OD Unit at TEAD began on July 7, 1997, and was conducted in three stages corresponding to the media of concern (i.e., surface soils/sediments, subsurface soil borings, and groundwater monitoring). The investigation was conducted commensurate with the Sampling and Analysis Plan (SAP) for the Subpart X OB/OD Unit at TEAD-N, Utah (June 1997) and the Tooele Army Depot Implementation Plan to Address the Utah OB/OD Permitting Guidance (June 1997). This summary report covers all tasks through the second groundwater sampling event on May 2, 1998.

All elements of the sampling and analysis were conducted in support of the RCRA Subpart X Permit Application being developed for the OB/OD Unit at TEAD. The purpose of this investigation is primarily to establish environmental baseline conditions. The specific objectives of the environmental baseline sampling were:

- Determining the degree to which demilitarization activities associated with the OB/OD Unit have impacted surface/subsurface soils and groundwater conditions within the unit and nearby area, and

Sampling surface soils from within specific zones (OB/OD, background, and boundary zone). Composite samples represent various exposure areas (source, operations, and impact) in order to characterize average contaminant levels within the OB/OD Unit. These data are used to define a source term input for a contaminant migration model for assessing potential off-site impacts.

The Environmental Sampling Study involved:

- Composite surface soil sampling and analysis of OB and OD source exposure areas; OB and OD operations exposure areas; OB and OD impact exposure areas; a background area; and a boundary zone area. Eight composite samples, each consisting of six equal portions, were collected at discrete (pre-selected) locations within each exposure area. Exact locations were based on the random sampling scheme presented in the SAP and described in Sect. 1.2.1.1. Note that the sector radii vary and are dependent on the exposure area being sampled.

Grab sampling of subsurface soils from split-spoons centered on 2, 5, 10, 20, 30, and 40 feet bgs at eight OD source (pit) areas with the highest surface TNT screening levels.

- Composite sediment sampling and analysis from eight locations downstream from OB/OD operations in Box Elder Wash. Each composite sample consisted of sediment from six discrete locations based on a random sampling scheme using a sector radius equal to half the width of the stream bed.
- Installation of one exploratory/monitoring well to determine groundwater quality and aquifer characteristics in the immediate vicinity of the OB/OD Unit. The direction and rate of groundwater flow were determined by using colloidal borescope techniques in the single monitoring well (MW-1).

1.2.1 Surface Soil and Sediment

Surface soil and sediment sampling were conducted at TEAD from July 7 to 12, 1997. A total of 81 composite surface soil/sediment samples (including 9 duplicates) were collected and shipped to Quanterra Laboratories in Knoxville, TN for analysis (see Tables 1.2 and 1.3). Additional QA split samples were also collected for five of the duplicate samples and subsequently analyzed by USACE at the South Atlantic Division (SAD) Laboratory in Marietta, GA. The total number of QA samples was reduced from 10% to 5%, as requested by the USACE Mobile District project manager (on-site).

The soil sampling strategy is based on concepts contained in the EPA Soil Screening Guidance (USEPA, May 1996) and the Utah Guidance for OB/OD treatment facilities. The strategy employs a statistically valid sampling approach for OB/OD sites and was designed to determine the mean contaminant concentrations in known or suspected exposure areas (i.e., source, operations, and impact areas). For this project, exposure areas have been delineated where contaminant patterns are likely to be different, based on knowledge of site use and historic information. The purpose of this approach was to divide the site into regions where the

Fig. 1.1

contaminant variability is most likely to be consistent. For this investigation the OB/OD Unit at TEAD has been divided into the following exposure areas:

Open Detonation Exposure Areas (EA)

1. Source EA - immediate pit area (limited by the crater walls).
2. Operations EA - the oblong area of disturbed or reworked soils surrounding the pits as delineated from aerial photographs and direct observation.
3. Impact EA - the area beyond the disturbed operations area and within the calculated impact zone. The zone of impact is defined as the debris/fragment throw range determined by TEAD ammo office for each OD pit. The radius used for this investigation was 2500 feet from an approximate geographic center of the active pits per discussion with the USACE Mobile District project manager on-site.

Open Burning Exposure Areas

1. Source EA - includes soils within 3 feet of burn pans.
2. Operations EA - includes soils outside of the source zone and within a 65-foot radius of each row of burn pans. The 65-foot radius is based on OB/OD field tests conducted at Dugway Proving Ground.
3. Impact EA - the area beyond 65 feet and within the area of impact (400 feet) based on Utah Guidance. The area of impact is equal to the minimum safe setback distance based on the gross explosive weight of the propellant. The maximum gross explosive weight of propellant per pan at TEAD is 1,000 lb. The minimum safe setback distance is 400 feet for a nonmissile OB hazard.

Boundary Zone Exposure and Background Areas

The site boundary zone (BZ) exposure area is located within the TEAD property boundary near the northern fence line. The area is approximately 3.5 miles north and downwind of the OB/OD Unit (Fig. 1.1).

The location is in an undisturbed area at the northwestern terminus of the ammo area away from soils potentially impacted by railroad operations. Considering the local prevailing winds and proximity to Grantsville, the area selected represents the maximum long-term exposure for the public. These soil quality data are required to evaluate potential off-site soil exposures as well as input for food-chain modeling to support the TEAD risk assessment.

The background (BKG) area is located on a 4-acre tract to the northeast of the OB/OD Unit, completely outside any potential impact area (Fig 1.1). This area was chosen because of the similar soil type (same alluvial fan morphology) as the OB/OD Unit, and the undisturbed nature (i.e., nongraded ridge and swale) with no roads or buildings nearby.

TEAD environmental personnel and a UDEQ official agreed on the precise locations for both the background and boundary zone sampling grids during a site visit in July 1997. Each grid consisted of eight composite sampling locations on 100-foot centers extending in a northeast to southwest direction for the BZ grid, and northwest to southeast direction for the BKG grid. Each composite sample consisted of six discrete random samples, as did all the OB/OD Unit composites. The discrete sample locations were restricted to a 25-foot radius from the center reference point.

1.2.1.1 Sampling Approach

A total of eight composite surface soil samples (each consisting of six discrete grab samples) were collected from each exposure area described above. This approach is based on the EPA Soil Screening Guidance (USEPA, 1996).

Six discrete sample locations were selected for each composite sample using the pie-shaped random sampling pattern shown in each sector of Fig 1.2. This random sampling (sector) pattern was used in the field for all composite samples to avoid biasing samples either toward or away from observed contamination (e.g., soil staining). The locations were determined in the field by measuring out proportionate distances of the specific radius (dependent on the EA) between the source and the outer boundary of that exposure area, along a unique azimuthal bearing.

1.2.1.2 Sample Locations

All exposure areas were sampled using the same basic strategy as outlined above. Eight composite samples were collected from each exposure area. Each composite sample consisted of six random individual samples (representing a discrete location within each sector). Although the surrounding operations and impact exposure areas are considerably larger than a particular source area, the potential for soil contamination is considered minimal and not as variable. Therefore, a less comprehensive sampling approach (looser grid) is required.

OD-source Exposure Area

Eight composite samples were collected from the OD source exposure area (representing eight separate pits). The eight pits were selected based on the highest TNT screening results from grab samples collected at all 19 pits (Appendix A). Each selected pit was then divided into six equal sectors per the random sampling pattern, and a grab sample was collected from discrete locations measured along a fixed bearing from the pit center to the rim. This random sampling pattern was used for locating all discrete sampling points to avoid biasing the samples either toward or away from observed contamination (e.g., soil staining). Fig. 1.3 shows the composite sampling scheme for the OD source exposure area.

Table 1.2

Table 1.2

Table 1.2

Table 1.3

OD-operations Exposure Area

Eight composite samples were also collected from the OD operations exposure area. Four samples were collected from discrete samples taken within the six sectors radiating from two separate point sources, which were located approximately at the geographic center of each cluster (group) of pits under investigation. Fig. 1.4 shows discrete sample locations within the OD operations exposure area(s). The location for each discrete sample was determined in the field by measuring the proportional distance along the azimuthal bearing from the point source area to the perimeter (475 feet) of the exposure area, per the random grid pattern.

OD-impact Exposure Area

The impact exposure area for the OD area is shown in Fig. 1.5. All sample locations were measured from one point source representing the entire cluster of active pits, and a 2,500-foot radius to the perimeter of the impact zone. Each of the eight composite samples representing the impact exposure area were collected from six discrete sample locations within the pie-shaped random sampling pattern shown in Fig. 1.2. The locations were determined by measuring out proportionate distances to corresponding numbers within each sector along the proper azimuthal bearing, between the source and outer boundary of the exposure area. Some sample locations were adjusted slightly with respect to distance along the same bearing so that all points fell within their proper exposure area.

OB-source Exposure Area

Eight composite soil samples were also collected from the OB source exposure area (burn pans). Each of these composite samples was composed of six discrete samples collected within 3 feet of individual or two combined burn pans. Fig. 1.6 illustrates the composite sample scheme for the OB source exposure area. The discrete samples within each surrounding exposure area were measured radially out from the eight source locations, which were centered between two adjacent burn pans, or in the case of Pan #15, directly on the center of the individual pan.

OB-operations Exposure Area

Fig. 1.7 illustrates the actual discrete grab sample locations for each composite sample within the OB operations exposure area. This exposure area consisted of two separate areas representing each row (group) of burn pans; it is similar to the two operations areas within the OD area that represent the separate clusters of sampled pits. The distance from source to the outer perimeter of the operations area is 65 feet.

Fig. 1.2

OB-impact Exposure Area

Fig. 1.8 illustrates the actual discrete grab sample locations for each composite sample within the OB impact exposure area. The distance from the source to the outer perimeter of the impact area is 400 feet. The locations were determined by measuring out proportionate distances between the source and the outer boundary of particular exposure areas along a unique azimuthal bearing as represented in the sector diagram. Some sample locations were adjusted slightly with respect to distance along the same bearing so that all points fell within their proper exposure area.

Background and Boundary Zone

Eight BKG and eight BZ composite surface soil samples were taken from each of their respective zones (Figs. 1.9 and 1.10). Each composite sample was located on 100-foot centers spaced along two rows with four samples on each row. The same sampling strategy applied where six individual (discrete) samples were collected for every composite using the same random grid pattern represented by the sector diagram. Since the variability of potential contaminants should not be affected by proximity to the source, a distance of 25 feet was arbitrarily chosen as a logistical limit for the sector radii.

On-site Drainage Channels

There are no permanent surface waters within the OD impact area. However, eight composite sediment samples were taken from ephemeral drainage channels in lieu of surface water to evaluate possible contaminant migration. Previous sediment analytical results did not indicate that migration of contaminants from the unit via the surface water pathway was a concern. However, sediment sampling was conducted as part of the environmental baseline study to determine if the surface water pathway is currently active and to establish baseline sediment quality data. Baseline conditions will serve as a comparison for future routine sediment sampling events. A total of eight sediment samples were taken downstream from OB/OD operations in Box Elder Wash (BEW), the nearest drainage. The sampling location approach is illustrated in Fig. 1.11. For maintaining consistent composite sampling techniques, each sample was composed of six discrete grab samples collected from the ephemeral channel bottom, using the same random grid pattern described above with a radius arbitrarily set at half the width of the channel.

Two of the sediment samples were collected from a tributary that does not flow directly through the OB exposure areas. Since no upstream sediment samples were collected, the analytical results can be compared to surface soil background results for a determination of sediment quality.

1.2.1.3 Sampling Procedures for Surface Soil/Sediment

Surface soil and sediment samples were collected using decontaminated stainless steel spoons and bowls. Surface soils from the OB/OD exposure areas consisted of composites from the top 2 cm of soil. This is based on the assumption that the top 2 cm are the most subject to wind

Fig. 1.3

Fig. 1.4

Fig. 1.5

Fig. 1.6

Fig. 1.7

Fig. 1.8

erosion, transport, and deposition from air. Equal volumes of soil from each discrete sampling location were placed in a stainless steel bowl to obtain the composite sample. The soil was then composited prior to placement in sample jars. Soil and sediment sampling was conducted in accordance with all protocols specified in the SAP.

For surface soil and sediment samples, each location was selected from random locations established within each exposure area sector shown in Fig. 1.9. The actual coordinates (latitude and longitude) for the sample point sources were stored in the memory of a hand-held, differentially corrected global positioning system (DGPS) and assigned a sample number. The DGPS data were used to plot accurate locations on the figures presented in this report and could be used to navigate back to each sample location at a later time.

1.2.1.3.1 Sampling Methods

Surface soil and sediment samples for chemical analysis were collected using decontaminated stainless steel spoons. The soil was homogenized in stainless steel mixing bowls prior to placement in the appropriate sample containers. Samples were analyzed for the parameters listed in Tables 1.2 and 1.3, following methods described in Sect. 1.3.

Surface soil and sediment samples submitted for metals and cyanide analysis were placed in 8 oz. clear, wide-mouth jars. Samples submitted for SVOCs and explosives analysis were placed in separate 8 oz. clear, wide-mouth jars. Aqueous samples submitted for metals and cyanide analyses were placed in 1-liter (L) high-density polyethylene bottles prepreserved with nitric acid and sodium hydroxide, respectively. Aqueous samples for SVOCs and explosives analysis were placed in three 1-L amber glass jars and cooled to 4°C. All samples were properly recorded on chain-of-custody forms included with each shipment. Minimum-maximum thermometers were also included in each cooler shipment, along with a temperature blank.

Equipment decontamination consisted of the following steps:

- Detergent wash (Liquinox),
- Tap water rinse,
- 10% solution nitric acid rinse,
- Tap water rinse,
- Isopropanol rinse,
- Deionized water rinse, and
- Air dry.

Fig. 1.9

Fig. 1.10

Fig. 1.11

1.2.1.3.2 Geotechnical Sampling

Two surface soil samples were collected from the OB/OD Unit and submitted for particle-size analysis. These samples were taken in the same manner as the surface soil samples for chemical analysis (composited from the top 2 cm over the exposure area). One sample was taken from the OD source zone (SS-OD-04) and one from the OB source zone (SS-OB-07). Samples were submitted to a geotechnical laboratory (Geotechnics, Inc.) for Standard Test Method Analysis of Soils ASTM D 422, particle-size analysis. A hydrometer analysis was performed on the sample fraction passing a No. 200 sieve. Results are used for air transport modeling.

1.2.2 Subsurface Soil

Subsurface soil borings and sampling events were conducted at TEAD from October 14 to 22, 1997. A total of 80 subsurface soil (grab) samples (including 8 duplicates) were collected from OD source and background areas and sent to Quanterra Laboratories in Denver, CO, for analysis. Additional QA split samples were also collected for four of the duplicate samples and sent to the USACE SAD Laboratory in Marietta, GA, for analysis. The total number of QA samples was reduced from the initial scope presented in the SAP, as requested by the USACE Mobile District project manager (on-site). Table 1.4 is a summary of the subsurface soil-sampling program. Field and quality assurance/quality control (QA/QC) samples are also shown in Table 1.4.

1.2.2.1 Sampling Approach

Discrete (grab) subsurface soil samples were required to determine specific contaminant concentrations at depth in areas of surface soil contamination. The data are necessary to determine the vertical extent of contamination and may be used for modeling.

1.2.2.2 Sample Locations

Subsurface soil data are necessary to determine the vertical extent of contamination in suspected source areas. Soil boring locations were limited to OD pits because U.S. Army field studies indicate most soil contamination at OD sites occurs within the immediate vicinity of the pit, and contamination associated with OB areas is generally related to surface soils. Borings were completed in the approximate center of eight OD pits (Fig. 1.12). Selection of the eight pits was based on the highest trinitrotoluene (TNT) field screening results from each of the 19 previously sampled (Appendix A). All locations and screening results were documented in the field notebook and on single-sample log sheets.

A total of 24 discrete subsurface soil samples were collected from four soil borings to establish background conditions. Background boring locations are shown on Fig. 1.9. Background borings were completed outside of areas subject to possible contaminant deposition from OB/OD activities and were co-located at four of the background surface soil locations at each corner of the sampling grid.

Table 1.4

Table 1.4

Table 1.4

1.2.2.3 Sampling Procedures for Subsurface Soils

Pit #5 (previously sampled for surface soil) was not sampled for subsurface soil because there was standing water in the crater. Pit #4 had the next highest TNT screening level and was therefore substituted in place of Pit #5. Each boring was completed to a depth of approximately 40 feet below the bottom of each pit. The subsurface samples were collected with 2-foot split-spoons (3Ø) centered on the 2-foot, 5-foot, 10-foot, 20-foot, 30-foot, and 40-foot depths. Each 2-foot sample was homogenized in a stainless steel mixing bowl prior to TNT field screening and placement in sample containers for laboratory analysis. Field analysis included screening for the presence of TNT by U.S. Environmental Protection Agency (EPA) Method 4050 (TNT in soil by Wet Chemistry).

1.2.2.3.1 Drilling Methods

Soil borings were completed using a Mobile B-57 drill rig and hollow stem augers. A built-in 150-pound pneumatic hammer was used to drive 3-in. outside diameter (OD) stainless steel split-spoons for soil sample collection. Use of 3-in. OD split-spoons will ensure the collection of sufficient sample volume; however, standard penetration testing (SPT) could not be applied. All soil samples were described according to the Unified Soil Classification System (USCS). Soil sampling and drilling were conducted in accordance with all standard operating procedures described in the SAP.

The potential existed for encountering UXO during drilling operations. All field activities conducted at the OB/OD Unit were in accordance with U.S. Army ordnance avoidance procedures specified in Appendix E of the SAP. At least one UXO specialist was on site at all times during intrusive field activities. The UXO specialist used surface and downhole metal detection equipment to clear sample points and conduct subsurface clearance as the auger and split-spoon was advanced.

Boring logs were maintained for each soil boring by a geologist or geotechnical specialist in accordance with standard operating procedures included in the SAP. See the attached boring and single sample log sheets. The logs contained descriptions of soils, the sample identification number, sample collection depths, dates, and times.

1.2.2.3.2 Sampling Methods

Subsurface soil samples for chemical analysis were collected using decontaminated stainless steel split-spoons. The soil from the split-spoon was placed in a stainless steel bowl and homogenized prior to placement in the appropriate laboratory-supplied sample containers. Samples submitted for SVOC and explosives analysis were placed in two 8 oz. clear, wide-mouth glass jars. Subsurface soil samples submitted for metals analysis were placed in 8 oz. clear, wide-mouth jars. Rinsate (aqueous) samples submitted for metals analysis were placed in 250 ml high-density polyethylene (HDPE) bottles and preserved with nitric acid to a pH of <2. Aqueous samples for cyanide analysis were placed in 100 ml HDPE bottles and preserved with sodium hydroxide to a pH of >12. Aqueous samples for explosives analysis were placed in one

Fig. 1.12

1-L amber glass jars. Aqueous samples for SVOC analysis were placed in two additional 1-L amber glass jars. Samples were preserved by cooling to 4°C.

All samples were properly recorded on chain-of-custody (COC) forms included with each shipment. Minimum-maximum thermometers were also included in each cooler shipment, along with a temperature blank. Field QC samples included field duplicates, rinsate, and temperature blanks. Field duplicates consisted of replicates of field samples. The soil sample was homogenized, divided into two or three equal parts, and aliquots of each part are used to fill sample containers. Duplicate samples were sent blindly to the laboratory (see COCs). Rinsate blanks consisted of analyte-free water rinsed over decontaminated sampling equipment and collected in sample bottles.

Equipment decontamination consisted of the following steps:

- Detergent wash (Liquinox),
- Potable water rinse (from TEAD-N Well #3),
- Solution nitric acid rinse,
- Tap water rinse,
- Isopropanol rinse,
- Deionized water rinse, and air dry.

1.2.3 Groundwater

The well (MW-1) was drilled during the months of November and December, 1997. Layne Christensen was subcontracted to use reverse circulation (ODEX) drilling methods in an attempt to drill and install a well using air as the only fluid. However, ODEX refusal was encountered at a dry depth of 448 feet, and further drilling required conversion to wet/mud rotary to complete the boring to a planned depth of 800 feet. Drill cuttings were logged throughout the ODEX drilling and resulted in a relatively accurate description of the predominantly gravelly sand sequence; however, when mud rotary operations began, the cuttings were observed for drilling breaks only and were not adequate for detailed boring descriptions. Borehole geophysics were ultimately needed to make hydrogeological interpretations for well placement. Subsequent geophysical logging indicated the shallowest potential for water bearing sediment was at 660 feet bgs. The monitoring well drilling and completion details were recorded in the field notebook and logs. The most pertinent information is summarized below and the boring/completion log is included in Appendix B.

1.2.3.1 Monitoring Well Location and Installation Requirements

One groundwater monitoring well was installed in an area estimated as downgradient of the OB/OD Unit in accordance with all applicable UDEQ rules and regulations. The proposed location was based on regional aquifer trends, sediment/bedrock interface, and local topography. The specific location of the monitoring well was mutually agreed upon by TEAD, USACE Mobile District, and UDEQ personnel.

Well drilling and construction techniques were based on the log of the closest existing well (N-6) in the vicinity of the OB/OD Unit boundary. Specific drilling, well installation, and groundwater sampling procedures were designed to meet the requirements of the Utah Regulations R315-7-13 for Groundwater Monitoring under RCRA and the U.S. Army Corps of Engineers Engineering Manuals EM200-1-3, Requirements for the Preparation of Sampling and Analysis Plans and EM1110-1-4000, *Monitor Well Design, Installation and Documentation at Hazardous and/or Toxic Waste Sites*.

1.2.3.2 Monitoring Well Drilling and Installation Procedures

Well drilling was conducted using dual-wall reverse circulation (DWRC) in combination with ODEX casing driver. The DWRC drilling method utilizes dual-wall pipe, top drive rotation, and a side inlet for injecting the drilling air. When drilling with this system, the drilling air is forced down the outer annulus of the dual-wall pipe to the drill bit where it is then directed to the center of the pipe. The drilling fluid returns the cuttings via the inner pipe at velocities in excess of 4,000 feet per min. After the geological sample reaches the surface through the inner pipe, it is discharged through a material handling hose into a cyclone separator. As the sample pours into the separator, the air is removed from the wet or dry sample and escapes through the top of the cyclone chimney. The sample then drops through the opening at the bottom of the cyclone into a container for bulk sampling.

The drilling rig used was a Schramm 850/350 unit with high-pressure air compressor rated up to 750 cfm free delivery at 250 psi. The air compressor had a dual operational air filter to remove entrained hydrocarbons. The environmental air filter was rated at 99.97% efficiency.

ODEX refusal occurred at a depth of 448 feet below ground level, and the 8-inch casing was initially stuck. Upon loosening and retracting the casing to 425 feet bgs, a decision to convert to mud rotary methods was approved, and plans were made to drill the boring to 800 feet or until the driller could confirm encountering the water table (whichever came first). Using a conventional mud rotary system, it was very unlikely that a clear indication of the saturated zone could be determined. Also, stratigraphic changes were not clear due to the lag and mixing of various sized cuttings retrieved at the surface. As a result, plans were made to use geophysical logging methods (i.e, natural gamma and resistivity) to characterize the hydrogeology after the boring reached a total depth of 800 feet.

Soils were either sampled through the bottom of a hollow stem auger (HSA) using a 3-in. OD split-spoon sampler or directly from the cyclone (reverse circulation air) depending on the drilling method employed. Split-spoon samples were initially taken while clearing the subsurface for UXO at the monitoring well location. This site UXO clearance operation was conducted at the end of the subsurface borings and sampling event in October 1997. The Schramm rig was brought on-site to start drilling the monitoring well boring on November 10, 1997. After the mud rotary operations began, the boring log descriptions were supplemented by geophysical results.

Split-spoon samples or soil cuttings were collected at 10-foot intervals and logged by a geologist or geotechnical engineer in accordance with the SAP. See the attached boring and completion report.

1.2.3.2.1 Geophysical Logging

Borehole geophysical logs (temperature, natural gamma ray, 16- and 64-in. normal resistivity and lateral log) were run by Century Geophysical Corporation on December 2, 1997. These logs were run after all drill rods and bit were tripped out of the hole and before installation of the well materials. Analysis of the logs indicated a series of good permeable saturated zones at about 720 feet below the top of ODEX casing. The shallowest indication of groundwater was at about 660 feet; however, potentially tight (low permeability) zones were not as clearly defined. These logs were used to determine the most productive zones (depths) where the limited screen (20 feet) should be installed.

1.2.3.2.2 Borehole Diameter and Depth

The well was drilled to a depth of 800 feet. The diameter of the borehole was 10 inches to a depth of 448 feet as a result of under-reaming for the 8-in. nominal ODEX casing; however, after conversion to mud rotary, the borehole diameter was 8 inches to total depth. The bottom of the well was set at 779.4 feet bgs and the natural gravel/sands allowed to collapse as the mud was thinned down.

1.2.3.2.3 Well Construction Materials

Casing/Screen

The well was constructed using a 4.85-in. OD (dependent on drilling method selected) flush-threaded Type 800/SDR-17 PVC (Eagle Plastics) riser pipe and well screens. No PVC solvents or glues were used. Two 10-foot lengths of continuous slot, factory-cut, well screen with a slot width of 0.010 in. was installed at a depth of 718.9 to 728.9 feet and 758.9 to 768.9 feet bgs. All well screens were set with at least 10 feet of the screen set below the saturated zone to account for possible seasonal variations in water levels. No nonaqueous phase liquids were observed or indicated by PID levels above background. Centralizers were installed at four levels above and below the screen intervals. A 10-foot blank casing was installed (with a cap) for a silt trap or sump at the bottom of the well at 779.4 feet bgs (see boring log/completion diagram).

Filter Pack, Bentonite, Grout

Clean, well-sorted 10/20 (Colorado Silica™) filter pack material was installed around the well screen to a level of 651.1 feet bgs. A bentonite slurry (Benseal™) was mixed for well-sealing purposes and pumped to a level of 626 feet bgs to construct a 25-foot seal on top of the filter material. Potable water was pumped in to wash the sand pack downhole, since bridging problems were substantial prior to installing the seal. The bentonite seal was allowed to set up for 3 hours prior to adding the first lift of grout.

A gel-cement grout seal consisting of 20:1 Type II Portland cement (Holnam Ideal™) to bentonite ratio was installed in four lifts from the top of the bentonite seal to the land surface. About 8 gallons of potable water per 94 lb. bag of cement were used. The grout mix was

pumped into the annular space under pressure through a tremie pipe placed at the top of the bentonite seal and raised along with the temporary casing during subsequent lifts.

Surface Completion

A 10-inch ID lockable painted steel protective casing was placed over the top of the PVC riser and sealed in the grout. This steel casing extends a few inches above of the top of the riser (2.84 feet above concrete base) and was grouted a minimum of 2.5 feet into the annular space. The steel casing was precoated with a rust-preventing primer and then painted a high-visibility yellow. The casing is vented to the atmosphere via a padlocked cap, which will prevent entry of rainwater. A 3-foot diameter by 6-in.-thick concrete pad was constructed around the well. Four protective posts painted yellow and constructed of 5-foot-long, 3-in.-diameter steel pipe were installed outside the pad to prevent damage to the well. Each post was placed a minimum of 2 feet in the ground and 3 feet above ground and located about 4 feet from the well.

Water Source

Potable water for well drilling, grout and bentonite mixing was obtained from an approved source at TEAD (production Well #3) and transported via water truck. Distilled water and deionized water for decontamination purposes was obtained from a USACE-certified laboratory or supplier.

1.2.3.2.4 Well Identification

The well has been initially identified by a generic number starting with the number MW-01, pending assignment of a TEAD unique number, which will be incorporated into its RCRA monitoring program. A permanently attached 3 x 5 in. brass plate with the well number, date drilled, total depth, top of casing elevation, and name of driller will be fastened to the well after completion of the survey.

1.2.3.2.5 Well Development

During well development (which started on December 13, 1997) it was evident, while bailing down the standing water column, that a problem existed. Neither the bailer nor the surge block would drop below the 358-foot level. Collapsed casing was suspected and investigated by running a downhole camera to look at the condition of the casing at that point. There was some evidence of grout seepage at the joint just above the blockage. A decision was made to try to ream out whatever grout existed and check the condition of the screen. A Mobile B-61 rig was brought on-site with a 4.125-in. tricone bit and NX rods to ream out the grout. The bit broke through the grout plug at about 515 feet and continued to verify that the well was clear to bottom.

Development continued by trying to flush out grout cuttings from the reaming. The bottom of the well was tagged at 771 feet below top of casing (btoc). Discharge (15-20 gpm) water was initially very turbid (grey/brown) but cleared up after about 25 minutes of pumping potable water from TEAD Well #3 through the bit.

The well was developed by surging and bailing primarily; however, a submersible pump was attempted unsuccessfully. At least six static volumes were removed (in addition to several standing volumes of added water). Over 1,100 gallons of water were purged over the development period. This was done until the discharge was clear and sediment free. Temperature, pH, and specific conductivity had not stabilized to within 10% for three consecutive measures; however, the remaining grout in the bottom apparently influenced the pH considerably. Nonetheless, a minimum of five times the standing water volume in the well casing, plus five times the water volume in the saturated gravel pack, were removed. Well development water was collected in the mud disposal pit. After development, a sample was collected in a clear glass jar, placed against a white background, and photographed.

1.2.3.2.6 Well Survey

A horizontal and vertical control location survey was conducted by a Utah-licensed firm (McNeil Engineering and Land Surveying) during the second groundwater sampling event. The surveyor used existing site control points to determine the coordinates and elevations of the new well per GPS specifications outlined in the SAP and SOW (See Appendix C).

For the monitoring well, the highest point (elevation) on top of the steel protective casing was surveyed to 5036.24 feet (msl). Horizontal location data were measured at latitude-longitude coordinates of 40° 29' 53.467" North and 112° 28' 10.572" West, respectively. The top of the steel riser pipe was notched at the point surveyed. A metal surveyor monument will be installed in the concrete pad to mark the survey point for surface elevation. Elevation data will be plotted on a drawing and top of casing elevations will be established for depth to groundwater reference measurements.

1.2.3.3 In-situ Permeability Testing - Colloidal Borescope

The colloidal borescope system was employed at TEAD in MW-1 on May 1 and 2, 1998. This system provides in-situ observation of natural colloids in groundwater wells, useful for determining the spatial distribution of local groundwater flow velocity. The system can measure both direction and rate of groundwater flow in low- and high-permeability material. The system's observational capabilities afford the potential for enhanced understanding of porous media flow at the most basic level. Groundwater flow velocities measured through the borescope system could be used to calibrate flow and transport models that better describe the movement of potential contaminants in the subsurface.

Components include a charge-coupled device camera, an optical magnification lens, an illumination source, a down-hole compass to assess the direction of natural flow, and a water-tight stainless steel housing. Approximately 60 cm long with a diameter of 44 mm, the borescope may be used in wells of 2-in. diameter or larger. The instrument transmits an electronic image to the surface through a cable, where a magnified image can be viewed on a high-resolution monitor.

A more detailed description of the results is included in Sect. 1.6, and the final report by Oak Ridge National Lab-Grand Junction (ORNL-GJ) is included in Appendix D.

1.2.3.4 Sampling Procedures for Groundwater

After well development and purging, groundwater samples were obtained from the new well (see Table 1.5). The purge water from the well was screened in the field for specific conductance, pH, and temperature in an attempt to assure that representative water was obtained from the aquifer. Purging for the first sampling event occurred on January 29, 1998, 19 days after well development was completed. The Bennett™ Piston Pump planned for groundwater sampling had just been specified and ordered after completion of the well. The special design and backorder on parts caused a delay of over 2 months before it could be delivered.

The initial groundwater sampling event was conducted on January 30, 1998, in order not to delay the sampling effort. The use of a large stainless-steel submersible pump was initially attempted; however, it was unsuccessful and a wire-line bailer method was employed. The water column was surged using this method and the resulting turbidity was slightly cloudy from material (grout cuttings), which had settled to the silt trap. Three volumes were purged prior to collecting the sample with a dedicated PVC bailer. The pH (9.75) and other parameters indicated that the sample may not be entirely representative of the groundwater and may contain some solids (i.e., grout cuttings, etc.). Indicator parameter results are shown in Appendix E.

The dedicated Bennett™ Pump was finally installed and used after the colloidal borescope investigation during the second sampling round conducted on May 4, 1998. A low-flow purging and sampling technique was successfully used to acquire a representative groundwater sample during the second round. This technique will be used for all future sampling events. For the baseline study, groundwater samples will be collected quarterly for one year.

1.2.3.4.1 Water Level Measurement

The depth to water was measured in the well to the nearest 0.01 foot from below the survey mark at the top of the steel casing (btosc) inside the locking cap. The static water level ranged from 627.0 in February 1998 to 626.02 feet btosc in May 1998. Depths were measured using an electronic tape (1000 feet) calibrated in 1/100-foot increments. Water levels were measured prior to purging the well for each sampling event. No free product was observed in the well.

Table 1.5

1.2.3.4.2 Field Measurement Procedures and Criteria

Well purging and field measurements of pH, temperature, and specific conductance were conducted in accordance with the procedures in the SAP and are included on field forms included in Appendix E.

1.2.3.4.3 Sampling Methods

A pre-cleaned and dedicated PVC bailer was used to collect the first groundwater samples for chemical analysis. The bailer was used for the first sampling event only because the Bennett™ pump had an extensive lead time necessary to special order and deliver the precise specifications for the new well. Sampling would have been delayed at least 3 months. The Bennett™ Pump was installed for the second and subsequent rounds of sampling using low-flow sampling protocols.

Groundwater samples for metals analysis were placed in 16-oz. HDPE containers that were pre-preserved with nitric acid to obtain a pH of <2. However, given the alkaline nature of the samples, the preservative amount may not have been sufficient to lower the pH to this standard. Samples for explosives analysis were placed in two 32-oz. amber glass jars and cooled to 4°C. Samples for SVOC analysis were also placed in two 32-oz. amber glass jars and cooled to 4°C. The sample for cyanide was placed in an 8-oz. HDPE container that was prepreserved with NaOH to obtain a pH of >12.

All samples were properly recorded on chain-of-custody (COC) forms included with each shipment. Minimum-maximum thermometers were also included in each cooler shipment, along with a temperature blank.

1.2.3.5 Decontamination Procedures

All downhole drilling equipment and sampling tools were decontaminated by washing equipment with high pressure hot water or steam prior to beginning work, between well borings, any time the drill rig left the site prior to completing a boring, and at completion of the drilling program. Well casings and screens were also steam cleaned prior to installation. A decontamination pad, large enough to hold the drill rig and allow for personnel movement around the rig, was located adjacent to the OB area and the road leading to the monitoring well. Decontamination water was collected according to the procedure for managing investigation derived waste (IDW). Split-spoon samplers were first decontaminated by steam cleaning before each use to avoid sample cross-contamination. All equipment used for collecting laboratory analytical samples were decontaminated prior to field sampling and between each use. The following decontamination steps were taken:

- Potable water rinse,
- Liquinox detergent wash,
- Potable water rinse,
- Distilled/deionized water rinse,
- Nitric acid rinse,

- Distilled/deionized water rinse,
- Isopropanol rinse,
- Distilled/deionized water rinse, and
- Air dry.

Field analytical equipment such as pH, conductivity, and temperature instrument probes were rinsed first with analyte-free water, then with the sample liquid before recording readings. The submersible pumps that were used were rinsed thoroughly with potable water. The pump interior was also flushed with a minimum of 15 gallons of potable water pumped from a plastic container. Following the flush, the exterior was rinsed with distilled/deionized water. Decontamination of sampling equipment was done in accordance with the SAP.

1.2.4 Investigation-derived Waste

The field investigation program generated both solid and liquid waste requiring on-site handling but no off-post disposal. The major types of waste generated and the requirements for their handling and disposition are summarized below.

1.2.4.1 Drill Cuttings

Drill cuttings from test borings in the pits were placed back in the boreholes. All drill cuttings from the monitoring well were inspected for volatile organics (PID screening) and discoloration. No odors or discoloration were present in the soil cuttings, and background PID readings were not exceeded. Since none of these elements were present, the cuttings were spread on the ground at the drilling site.

1.2.4.2 Development and Purge Water

The water itself was inspected for unusual odors or unnatural discoloration. The pH, conductivity, and temperature were also analyzed in the field. None of the evaluations revealed unnatural conditions or obvious gross contamination; however, the pH was abnormally high probably due to the grout cuttings produced from reaming out the well casing. The purge water was contained in the lined pit (used for drilling mud disposal) located adjacent to MW-1. Based on the analysis of groundwater, the pit fluids will be allowed to evaporate, the liner will be removed, the sludge/sediment will be covered with the excavated natural soils, and the surface re-graded.

1.3. LABORATORY ANALYSIS AND QA/QC

Analytical requirements for all laboratory samples are listed in Tables 1.2 to 1.5. A USACE-approved laboratory was selected for the analytical program. The analytical methods used followed Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (EPA SW-846) and Methods for the Determination of Metals in Environmental Samples (EPA 600/4-91/010).

Laboratory analysis for all samples (both soils and aqueous) included:

- Semivolatile organic compounds (EPA Method 8270B); see SAP/QAPP for complete list of compounds).
- RCRA metals (EPA Methods 6010A and 7471/mercury).
 - arsenic
 - barium
 - cadmium
 - chromium
 - lead
 - mercury
 - selenium
 - silver
- Other metals (EPA Method 6010A).
 - aluminum
 - beryllium
 - copper
 - iron
 - potassium (as an indicator for black powder)
 - manganese
 - nickel
 - sodium
 - thallium
 - vanadium
 - zinc
- Cyanide (EPA Method 9010).
- Explosive compounds (EPA Method 8330).
 - HMX
 - RDX
 - TNB
 - tetryl
 - DNB
 - TNT
 - NB
 - 2,4-DNT
 - 2,6-DNT
 - 2-AM-DNT
 - 4-AM-DNT
 - 2NT
 - 3NT
 - 4NT
 - TNG
 - PETN

The laboratory selected for chemical analyses, Quanterra, has been certified by the State of Utah and approved by the U.S. Army Corps of Engineers (USACE) Missouri River Division (MRD). The laboratory to be used has been certified for all parameters needed for the TEAD baseline open burning/open detonation (OB/OD) site investigation with the exception of beryllium. However, although beryllium was detected at some locations slightly above background during the RFI, this metal is not included in the standard RCRA metals list and is not typically associated with OB/OD operations.

1.3.1 Analytical Procedures

1.3.1.1 Metals Analysis by Inductively Coupled Plasma (ICP)

Estimated practical quantitation limits (PQLs) using SW-846, as well as mean detection limits (MDLs) for the selected laboratory, for samples of either a water or soil matrix are shown below (Table 1.6). These values are compared to screening criteria.

Table 1.6. Metals analysis by inductively coupled plasma (ICP)

Metals	IDLs (µg/L) ^a	Water (µg/L)			Soil (mg/kg)		
		PQL ^b	MDLs	Screening criteria ^c	PQL ^b	MDLs	Screening criteria ^c
Aluminum	45	200	21	37,000	20	21	78,000
Arsenic	53	10	2.3	>1-11	1.0	0.29	>1-23
Barium	2	200	1.6	2,600	20	0.19	5,500
Beryllium	0.3	5	0.23	0.016	0.5	0.28	0.15
Cadmium	4	5	3.8	18	0.5	0.38	39
Chromium	7	10	4.7	180-37,000	1	0.52	390-78,000
Copper	6	25	5.7	1,500	2.5	2.4	3,100
Iron	7	100	22	11,000	10	2.6	23,000
Lead	42	3	1.8	0.15 ^(d)	0.3	0.12	4,000
Potassium	75	5,000	22	NA	5,000	46	NA
Manganese	2	15	1.5	840	1.5	0.29	1,800
Mercury	0.2	0.2	0.03	11	0.033	0.019	23
Nickel	15	40	9.7	730	4	1.2	1,600
Selenium	75	5	4.3	180	0.5	0.36	390
Silver	7	10	5.8	180	1	0.37	390
Sodium	29	5,000	32	NA	5,000	4.6	NA
Thallium	40	10	48	NA	1	5.3	NA
Vanadium	8	50	8.3	260	5	1.5	550
Zinc	2	20	5.8	11,000	2	0.67	23,000

^a Instrument detection limits (IDLs) shown are a guide for an instrumental limit at the wavelengths recommended within the method.

^b PQLs determined for samples vary depending upon the sample matrix. USACE has established these levels as estimated PQLs (commensurate with SW-846).

^c U.S. EPA Region III (April 1996).

^d Revised Interim Soil Lead Guidance for CERCLA and RCRA Corrective Action Facilities, Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12, July 14, 1994.

NA = Not available

1.3.1.2 Explosives Analysis by Method 8330

The procedure for analysis of explosives in soil and water is SW-846 Method 8330 by high performance liquid chromatography (HPLC). The estimated SW-846 PQLs, as well as MDLs for the selected laboratory, using this method are shown below (Table 1.7). These values are compared to screening criteria.

Table 1.7. Explosives Analysis by Method 8330

Explosives	Water (µg/L)			Soil (mg/kg)		
	PQL ^a	MDLs	Screening criteria ^b	PQL ^a	MDLs	Screening criteria ^b
HMX	50	0.05	NA	0.50	0.05	NA

RDX	50	0.05	NA	0.50	0.05	NA
TNB	20	0.03	1.8	0.25	0.02	3.9
Tetryl	20	0.05	NA	0.65	0.05	NA
DNB	20	0.03	3.7	0.25	0.02	7.8
TNT	20	0.04	2.2	0.25	0.03	21
NB	20	0.03	14	0.25	0.03	39
2,6 DNT	20	0.06	37	0.25	0.02	78
2,4 DNT	20	0.03	73	0.25	0.02	160
2-AM-DNT	20	0.04	NA	0.25	0.03	NA
4-AM-DNT	20	0.05	NA	0.25	0.04	NA
2NT	20	0.05	61	0.25	0.05	780
4NT	20	0.04	61	0.25	0.05	780
3NT	20	0.04	61	0.25	0.06	780
PETN ^c	200	0.52	NA	2.5	0.43	NA
TNG ^d	200	0.44	3,700	2.5	0.86	7,800

^a Guidance Method Limits; these values are laboratory-specific and will be established when the contract laboratory is procured.

^b U.S EPA Region III Risk-Based Concentration Table (Values for tap water and residential soil).

^c PETN is an add-on to Method 8330.

^d TNG is an add-on to Method 8330.

NA = Not available

1.3.1.3 Semivolatile Compound Analysis by Method 8270

Semivolatile organic analysis will be performed using EPA Method 8270. PQLs using SW-846, as well as MDLs for the selected laboratory, for samples of either a soil or water matrix are shown below (Table 1.8). These values are compared to screening criteria.

Table 1.8. Semivolatile Compound Analysis by Method 8270

Analyte	Water (µg/L)			Soil (mg/kg)		
	PQL	MDL	Screening criteria ^a	PQL	MDL	Screening criteria ^a
Phenol	10	1.38	22,000	0.330	0.0165	47,000
bis(2-Chloroethyl)ether	10	1.45	NA	0.330	0.0527	NA
2-Chlorophenol	10	1.35	180	0.330	0.0155	390
1,3-Dichlorobenzene	10	1.29	540	0.330	0.0168	7,000
1,4-Dichlorobenzene	10	1.30	0.44	0.330	0.0185	27
1,2-Dichlorobenzene	10	1.19	270	0.330	0.0200	7,000
2-Methylphenol	10	1.09	1,800	0.330	0.0544	3,900
2,2-Oxybis(1-Chloropropane)	10	1.83	NA	0.330	N/A	NA
4-Methylphenol	10	1.40	180	0.330	0.0377	390
N-Nitroso-di-n-propylamine	10	1.54	NA	0.330	0.0175	NA
Hexachloroethane	10	1.10	0.75	0.330	0.0164	46
Nitrobenzene	10	1.76	3.4	0.330	0.0151	39
Isophorone	10	1.66	71	0.330	0.0176	670
2-Nitrophenol	10	1.64	2,300	0.330	0.0127	4,800
2,4-Dimethylphenol	10	1.07	730	0.330	0.0375	1,600
bis(2-Chloroethoxy)methane	10	1.54	NA	0.330	0.0182	NA
2,4-Dichlorophenol	10	1.35	110	0.330	0.0115	230
1,2,4-Trichlorobenzene	10	1.29	190	0.330	0.0174	780
Naphthalene	10	1.56	1,500	0.330	0.0186	3,100
4-Chloroaniline	10	1.23	150	0.330	0.0311	310
Hexachlorobutadiene	10	1.20	0.14	0.330	0.0234	8.2
4-Chloro-3-methylphenol	10	1.37	NA	0.330	0.0186	NA
2-Methylnaphthalene	10	1.10	NA	0.330	0.0213	NA
Hexachlorocyclopentadiene	50	4.69	0.15	1.600	0.0100	550
2,4,6-Trichlorophenol	10	1.10	61	0.330	0.0117	58
2,4,5-Trichlorophenol	10	1.20	3,700	0.330	0.0219	7,800
2-Chloronaphthalene	10	1.21	NA	330	0.0163	NA
2-Nitroaniline	50	1.30	2.2	1.600	0.0158	4.7
Dimethylphthalate	10	1.41	370,000	0.330	0.0174	780,000
Acenaphthylene	10	1.54	NA	0.330	0.0175	NA
2,6-Dinitrotoluene	10	1.34	37	0.330	0.0173	78
3-Nitroaniline	50	1.22	11.0	1.600	0.0307	230
Acenaphthene	10	1.22	NA	0.330	0.0164	NA
2,4-Dinitrophenol	50	3.79	730	1.600	N/A	1600
4-Nitrophenol	50	1.37	2,300	1.600	N/A	4,800
Dibenzofuran	10	1.19	150	0.330	0.0202	310
2,4-Dinitrotoluene	10	1.33	73	0.330	0.0166	160

Table 1.8. (Continued)

Analyte	Water (µg/L)			Soil (mg/kg)		
	PQL	MDL	Screening criteria ^a	PQL	MDL	Screening criteria ^a
Diethylphthalate	10	1.57	29,000	0.330	0.0219	63,000
4-Chlorophenyl-phenylether	10	1.42	NA	0.330	0.0245	NA
Fluorene	10	1.58	NA	0.330	0.0218	NA
4-Nitroaniline	50	1.48	11.0	1.600	0.0302	230
4,6-Dinitro-2-methylphenol	50	1.14	NA	1.600	0.0123	NA
N-Nitrosodiphenylamine	10	1.55	14	0.330	0.0149	130
4-Bromophenyl-phenylether	10	1.53	2,100	0.330	0.0210	4,500
Hexachlorobenzene	10	2.10	0.0066	0.330	0.0240	0.4
Pentachlorophenol	50	1.19	0.56	1.600	0.0194	5.3
Phenanthrene	10	2.04	NA	0.330	0.0181	NA
Anathracene	10	1.52	11,000	0.330	0.0201	23,000
Carbazole	10	2.65	3.4	0.330	0.0197	32
Di-n-Butylphthalate	10	1.63	NA	0.330	0.0141	NA
Fluoranthene	10	1.63	1,500	0.330	0.0196	3,100
Pyrene	10	1.67	1,100	0.330	0.0166	2,300
Butylbenzylphthalate	10	1.54	7,300	0.330	0.0143	16,000
3,3'-Dichlorobenzidine	50	3.23	0.15	1.600	0.0560	1.4
Benzo(a)anthracene	10	1.98	0.092	0.330	0.0212	0.88
Chrysene	10	2.19	9.2	0.330	0.0208	88
bis(2-Ethylhexyl)phthalate	10	1.60	NA	0.330	0.0133	NA
Di-n-Octylphthalate	10	1.11	NA	0.330	0.0156	NA
Benzo(b)fluoranthene	10	1.94	0.092	0.330	0.0205	0.88
Benzo(k)fluoranthene	10	1.85	0.92	0.330	0.0189	8.8
Benzo(a)pyrene	10	1.28	0.0092	0.330	0.0168	0.088
Indeno(1,2,3-cd)pyrene	10	1.38	0.092	0.330	0.0169	0.88
Dibenz(a,h)anthracene	10	1.39	0.0092	0.330	0.0147	0.088
Benzo(g,h,l)perylene	10	1.38	NA	0.330	0.0153	NA

^a U.S. EPA Region III Risk-Based Concentration Table (Values for tap water and residential soil).

1.3.1.4 Cyanide Analysis by Method 9010

The procedure for analysis of cyanide is SW-846 Method 9010 by titration. The estimated SW-846 PQL, as well as the MDL for the selected laboratory, using this method are shown below (Table 1.9). These values are compared to screening criteria.

Table 1.9. Cyanide analysis by method 9010

Analyte	Water ($\mu\text{g/L}$)			Soil (mg/kg)		
	PQL	MDL	Screening criteria ^(a)	PQL	MDL	Screening criteria ^(a)
Cyanide	10	1.7	730	0.5	0.2	1,600

^aU.S. EPA Region III Risk-Based Concentration Table (values for tap water and residential soil).

1.3.2 TNT Field Screening

Field screening for the presence of TNT was conducted on all surface soil, subsurface soil, and sediment samples according to EPA Method 4050 (TNT Explosives in Soils), a wet chemistry method for soils. This method provides semi-qualitative/semi-quantitative data (meaning that contaminant identification is not definitive and quantitation is estimated). The range of the ENSYS™ TNT Soil Test System is between 1 and 30 parts per million (ppm) combination of TNT/TNB/DNT. The relative standard deviation is 8%, and the least detectable concentration is 0.7 ppm. A control sample was run each day to ensure that the instruments were operating properly. The procedure works by adding controls, samples, and color-change reagents to cassettes and determining concentrations for TNT based on evaluation of color changes measured by the Hach DR/2000 spectrophotometer.

Average surface soil TNT concentrations based on laboratory analysis have been compared with field screening results (see Table 1.10). TNT field screening results for each composite surface soil sample are provided in Appendix A. A comparison of discrete subsurface soil TNT results is presented in Table 1.11. These results indicate that the field screening approach significantly overestimates TNT surface soil concentrations. Available groundwater TNT samples were classified as nondetection results based on both lab and field screening approaches. In conclusion, TNT field screening can be used (as appropriate) for routine soil monitoring to reduce analytical laboratory costs (i.e., only send samples to the lab for analysis that exceed screening levels for TNT) if TNT is considered the only energetic contaminant of concern (based on the risk assessment).

1.3.3 Data Quality Objectives (DQO)

Data quality objectives (DQOs) are requirements needed to support decisions relative to various stages of the project. The data needs associated with this project have been developed based upon evaluation of existing site data and subsequent risk assessment needs. A determination was made as to what additional data were necessary to establish environmental baseline conditions at the OB/OD Unit. Specific data needs included development of mean contaminant concentrations across the site and their potential for imparting public health risks and environmental impacts.

Table 1.10

Table 1.11

The purpose of the environmental sampling study was to collect representative samples of soil and sediments that can be analyzed to identify contaminants of concern.

Identification of contaminants of concern is necessary for predicting contaminant concentrations and the potential for migration to off-site receptors. If unacceptable levels of contaminants are determined to be migrating to off-site receptors, this could result in the need for changing the mode of operations, instituting immediate corrective actions, or permit denial. The analytical data needed to support these decisions must be of known defensible quality.

1.3.3.1 QA Objectives for Chemical Data Measurement

The quality of the laboratory data is assessed in terms of precision, accuracy, representativeness, comparability, and completeness. Details were presented in the SAP.

1.4 DATA VALIDATION

1.4.1 Methodology

This section discusses the purpose of data validation, the guidance used during the process, and the methodologies used for the review of the organic (semivolatile organic compounds (SVOCs)), inorganic, and explosive chemical constituents data produced as a result of the sampling effort at the OB/OD Unit at TEAD. This section also presents an analysis of the 1) data validation results and trends, and 2) triplicate results.

1.4.1.1 Purpose

Data validation is an objective systematic process of data review that evaluates a variety of method quality control parameters. These parameters, discussed in detail below, include the following:

- Holding Times
- Gas Chromatograph/Mass Spectrometer (GC/MS) Instrument Tuning (SVOCs only)
- Calibration Compliance
- Laboratory Blank Results
- ICP Check Sample Results (metals only)
- Surrogate Recoveries (organics only)
- Matrix Spike Results
- Internal Standard Results (organics only)
- Laboratory Control Sample Results
- ICP Serial Dilution Results (metals only)
- Sample Quantitation
- Detection Limits
- Overall Assessment

The data validation objectives are three-fold:

- To provide assurance that the data quality objectives have been maintained by the analytical laboratory;
- To eliminate the potential for false positives (laboratory or field blank contaminants) and false negatives; and
- To assign qualifications to those parameters that have not met quality control criteria.

The intended uses of the environmental sampling data collected for the OB/OD Unit at TEAD included site characterization and human health risk assessment. To ensure that the data reported by the laboratory(ies) were capable of supporting the intended uses, a review equivalent to EPA DQO Level IV of the environmental sampling data was performed.

Data packages provided by the laboratory(ies) for the analysis of aqueous, soil, and sediment samples collected at TEAD were analyzed in accordance with CLP protocols. Data review was conducted in accordance with USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA540/R-94-012), February 1994; and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA540/R-94-013), February 1994 for the organic and inorganic data, respectively (U.S. EPA, February 1994a; U.S. EPA, February 1994b).

The data validation objectives identified above are designed to provide valid or usable data and to eliminate faulty or unusable data. Qualifications are assigned to data based upon compliance to parameters detailed in the EPA guidelines. Valid data are typically represented by qualifications such as U, J, and UJ. Rejected or unusable data are presented by qualifications such as R and UR. The data validation qualifiers are defined as follows:

- U Nondetected result.
- J Estimated quantity as a result of a minor noncompliance.
- UJ Nondetected result that has been qualified as estimated as a result of a minor noncompliance.
- R Positive result that has been rejected and considered unusable as a result of a major noncompliance.
- UR Nondetected result that has been rejected and considered unusable as a result of a major noncompliance.

1.4.1.2 Evaluation of Organic and Inorganic Data

Organic (semivolatile and explosive compounds) and inorganic analytes (target analyte metals, cyanide and percent solids) were evaluated in accordance with the EPA guidelines previously identified with the exception of percent solids; data validation for percent solids included review for duplicate analysis only.

A preliminary review of each sample delivery group (SDG) or project number included a review of the chain-of-custody records to confirm proper identification of the samples, sample matrix,

dates of sampling, and analysis to be performed. The chain-of-custody records identified trip blanks, field duplicates, and MS/MSDs within the SDG. The preliminary review also included a review of the SDG narrative, which provided a listing of the samples included in the SDG or project, a listing of the methodologies, and a description of notable problems encountered during sample analysis. Subsequent review of the data included the following method quality control parameters:

Holding Times

Holding times are defined as the period of time between the date of sample collection and date of preparation and/or analysis. The semivolatile organic fraction technical holding times are 7 days (waters) and 14 days (soils) from the time of collection to sample extraction and 40 days from time of extraction to time of sample analysis. The maximum technical holding times for water and soil/sediment samples are 180 days for the metals, 28 days for mercury analysis, and 14 days for cyanide analysis.

Gas Chromatograph/Mass Spectrometer (GC/MS) Instrument Tuning (SVOCs only)

Review of the GC/MS instrument tuning evaluated the reliability of mass assignment and relative abundance criteria.

Calibration Compliance

Review of instrument calibration information ensured that the instrument was capable of producing acceptable organic and inorganic analyses. Initial calibration demonstrates that the instrument was capable of acceptable performance and of producing a linear calibration curve. Continuing calibration analysis verifies the accuracy of the initial calibration curve. Continuing calibrations compare the response of the instrument on a periodic basis. The response determined in the continuing calibration was compared to method requirements.

For organic analyses, initial calibration evaluation included confirmation of proper standards usage, and a review of standard relative response factors (RRFs) and the percent relative standard deviations (%RSD) for each analyte of interest. Sample data for positive and nondetected results were qualified as estimated when the percent relative standard deviation and relative response factor criteria did not meet established criteria. Sample data for nondetected results were rejected when the initial calibration RRFs did not meet the established minimum criteria.

Continuing calibration standards for organic analyses were evaluated relative to their associated initial calibrations. The continuing calibration review evaluated the frequency of calibration, correctness of the continuing calibration, cross-reference to the appropriate initial calibration, and an examination of both continuing calibration relative response factors and percent differences (%Ds) from the initial calibration. Sample data for positive and nondetected results were qualified as estimated when the percent differences and relative response factor criteria did not meet established criteria. Sample data for nondetected results were rejected when the continuing calibration relative response factors did not meet the established minimum criteria.

For inorganic analyses, data review of initial calibrations included an evaluation of the frequency of calibration and the appropriate number of standards used during calibration, and confirmation that the percent recoveries (%Rs) met the quality control requirements. Mercury analysis was performed using the Cold Vapor Atomic Absorption (AA) technique. As a result, review of the mercury analysis included an evaluation of the calibration curve or correlation coefficient. The analysis of total cyanide was performed by distillation and colorimetric procedures; as a result, a calibration curve or correlation curve was also evaluated.

Continuing calibration verification review for inorganic analyses included 1) a review to determine that continuing calibration verification standard percent recoveries were within acceptable quality control limits, and 2) an analysis of standards for each target analyte at the proper frequency and placement within the analysis run.

Laboratory Blank Results

The review of method/field quality control blanks is conducted to assess if contaminants are present as a result of laboratory and/or field activities. Positive results detected in these blanks were summarized. The maximum concentration of contaminants was then used and an action level established. Analytes detected at concentrations below the action level were considered false positives and were qualified as nondetected.

Inductively Coupled Plasma (ICP) Interference Check Sample Results (metals only)

ICP Interference Check Sample evaluation assesses the impact of high concentrations of interfering analytes, namely aluminum, calcium, iron, and magnesium, upon other target analytes within a given sample. Review of ICP interference check sample results included the frequency of analysis, percent recoveries of spiked analytes, and an evaluation of results for nonspiked analytes whose absolute value exceeded the IDL. Analytes whose absolute value exceeded the instrument detection limit were used to calculate an estimate of potential interference. Positive sample results were qualified as estimated if the calculated estimated result was greater than 10% of the sample result. Sample data for positive and nondetected results were qualified as estimated if analyte concentrations indicated the presence of false positives and false negatives. Since calcium and magnesium analysis were not performed, ICP interference check sample evaluation was not performed for these analytes.

Surrogate Recoveries (organics only)

Review of surrogate recoveries is conducted to monitor the extraction efficiency of the samples. Data review included confirmation of acceptable percent recoveries. Sample data for positive and nondetected results were qualified as estimated when the surrogate percent recoveries were less than the minimum established criteria. Positive results were qualified as estimated when the surrogate percent recoveries were greater than the established criteria. Sample data for nondetected results were rejected when surrogate percent recoveries were less than 10%.

Matrix Spike Results

Matrix Spike/Matrix Spike Duplicate analyses provide information on the impact of the sample matrix upon sample analysis. MS/MSD review included the confirmation that the MS/MSD was performed at the required frequency, the spike percent recoveries were acceptable, and the RPD between the MS and MSD recoveries met the established criteria. For organic analyses, no qualification action was taken on MS/MSD data alone; however, discrepancies were noted in the SDG narrative. For inorganic analyses, sample data for positive and nondetected results were qualified as estimated when the percent recoveries exceeded established criteria.

Internal Standard Results (SVOAs only)

Internal standards are used in quantitation of sample results. Internal standard review included verification that the retention times and the internal standard areas were within established criteria. Sample data for positive and nondetected results were qualified as estimated when the established retention time criteria were not met. Sample results for positive and nondetected data were qualified as estimated when the internal standard results did not meet the established quality control criteria.

Laboratory Control Sample Results

The Laboratory Control Sample (LCS) serves as a monitor of the overall performance of each step during the analysis, including sample preparation. Review of the data included evaluation of the frequency of the LCS analysis and confirmation that the percent recoveries were within established quality control limits and were properly calculated.

ICP Serial Dilution Results (metals only)

Serial dilution of samples quantitated by ICP determines whether or not significant physical or chemical interferences were present due to sample matrix. Review of the data included evaluation of the percent difference calculation and confirmation that results were within established quality control limits. Sample results were qualified as estimated when the percent difference was greater than 10%.

Sample Quantitation and Detection Limits

The purpose of reviewing compound quantitation, Contract Required Quantitation Limits (CRQLs) (for organic compounds), and Practical Quantitation limits (PQLs) (for inorganic analytes) is to ensure accurate reporting. The CRQLs and PQLs were reviewed to confirm they had been adjusted to consider sample aliquot, sample dilutions, and percent moisture. Sample results reported below the CRQL for organic compounds (SVOAs and explosives) were qualified as estimated.

Overall Assessment

The purpose of the overall assessment is to provide a brief narrative in which the data reviewer expresses concerns and comments on the data quality and, if possible, the usability of the data. Evaluation included review of the overall data, considering the additive nature of any analytical problems, and verification of proper data transcription. Verification results were reported within

the linear range of the instrument. No qualifications of sample data were performed for this portion of data validation; instead the SDG qualification issues were explained in the data validation narrative and summarized in a recommendation summary table.

1.4.2 Results

Validation of sample data provides information about its usability. Data are considered usable when associated with a qualifier of “U” (nondetected result), “J” (estimated quantity as a result of a minor noncompliance), or “UJ” (nondetected result that has been qualified as estimated as a result of a minor noncompliance). Data are considered unusable when associated with a qualifier of “R” (positive result that has been rejected and considered unusable as a result of a major noncompliance), or “UR” (nondetected result that has been rejected and considered unusable as a result of a major noncompliance). All of the data are considered usable unless a qualifier of “R” or “UR” is associated with the analyte.

Table 1.12, Reasons for Data Rejection by SDG, presents the parameters determined to be unusable after completion of data validation and the reasoning associated with this determination. All rejected data were associated with nondetected results. There were 168 samples validated for organic (including semivolatiles and explosives) and inorganic analyses. Only data associated with organic compounds were determined to be unusable during data validation. Of the 16,500 organic and inorganic analyses validated, less than 0.01% were rejected (i.e., equivalent to a data recovery of 99.99%). Calibration problems associated with 2,2'-oxybis(1-chloropropane), a semivolatile organic compound, account for 33% of the samples containing rejected or unusable data.

Table 1.13, Reasons for Data Qualification by SDG, presents the parameters determined to be estimated after completion of data validation and the reasoning associated with this determination. All analyses qualified as estimated during the data validation process are considered valid or usable data. Minor qualifications assigned to samples analyzed for organic compounds include positive results reported at concentrations below the instrument detection limit, continuing calibration percent differences greater than the established criteria of 25% (SVOAs compounds) or 15% (explosive organic compounds), blank contamination, surrogate recoveries outside of the quality control limits, and low internal standard areas. Minor qualifications assigned to samples analyzed for inorganic analytes include blank contamination, ICP interferences, ICP serial dilution percent difference noncompliance's, and MS/MSD percent recovery noncompliance's.

Table 1.12. Reasons for data rejection by SDG

SDG/number of samples	Parameter	Result/reason for rejection
BR650/20 samples	2,2'-oxybis (1-chloropropane)	UR/initial calibration RRF below 0.05
BR651/19 samples	2,2'-oxybis (1-chloropropane)	UR/initial and continuing calibration RRFs below 0.05

BR651/8 samples	acid fraction ^a	UR/2,4,6-tribromophenol surrogate recovery less than 10%
BR652/5 samples	2,2'-oxybis (1-chloropropane)	UR/initial and continuing calibration RRFs below 0.05
BR654/3 samples	2,2'-oxybis (1-chloropropane)	UR/initial and continuing calibration RRFs below 0.05

^a Acid fraction semivolatile organic compounds are 2,4,5-trichlorophenol; 2,4,6-trichlorophenol; 2,4-dichlorophenol; 2,4-dimethylphenol; 2,4-dinitrophenol; 2-chlorophenol; 2-methylphenol; 2-nitrophenol; 4,6-dinitro-2-methylphenol; 4-chloro-3methylphenol; 4-methylphenol; 4-nitrophenol; pentachlorophenol, and phenol.

As a result of data validation activities, the sample data collected at TEAD is considered usable and valid, with the exception of those samples rejected as a result of calibration and surrogate recovery noncompliance's. Table 1.14, Samples Grouped by SDG or Project Number, presents the samples as they were grouped for analyses by the laboratory. This grouping eases the analysis and validation processes. Appendix H has the baseline sampling program validated database (electronic data file).

1.4.3 Triplicate Results

During the field sampling, duplicate and triplicate samples were pulled from the same location as the original sample to confirm overall precision. According to the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, field duplicate samples are used to measure both field and laboratory precision; therefore, the results may have more variability than the laboratory duplicates that measure only laboratory performance. In addition, soil duplicate results will have greater variance than water matrices because of the difficulties associated with collecting identical field samples. Keeping the data collection process constant,

Table 1.13

Table 1.13

Table 1.13

Table 1.13

triplicate samples are used to compare the data generated by one laboratory against that of another. For the surface soils, subsurface soils, and groundwater monitoring well samples collected at TEAD, duplicate and triplicate samples were collected as specified in the Sect. 1.2 of this Attachment. The original and duplicate samples were sent for analysis to the primary laboratory. The triplicate samples were sent to a separate laboratory designated by the U.S. Army Corps of Engineers-Mobile District.

Appendix Tables F.1, Surface Soils QA Results, F.2, Subsurface Soils QA Results, and F.3, Groundwater Monitoring Well QA Results, present comparisons of the original, duplicate and triplicate sample results for the surface soils, subsurface soils, and groundwater monitoring wells, respectively. The tables also present the PQL and Screening Level (SL) (for industrial and residential uses for the soil samples, and for residential use for the groundwater monitoring well samples) for each analyte or compound analyzed. Calculations presented on the table include the RPD between the original and duplicate samples, and the RPD for the average (original and duplicate samples) and the triplicate sample.

Analyses for all parameters performed for the original, duplicate, and triplicate samples for the surface soils samples are presented in Appendix F. Some triplicate samples were not collected for the surface and subsurface soils; these samples are denoted by a “Not Sampled” directly under the sample identification. Some triplicate samples for the subsurface soils and groundwater monitoring well samples were not analyzed for all of the parameters identified in the sampling and analysis plan; these parameters are noted in the tables as “NR” for “Not Reported.” Two subsurface soils samples collected for triplicate analyses were sent to the QA laboratory, but no results were received; these samples are denoted by a “Not Received” directly under the sample identification.

Analysis of the field duplicate and triplicate results was performed using the U.S. EPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis, June 13, 1988. These guidelines establish RPD acceptability criteria for field duplicate samples; the criteria are 50% for soil samples and 30% for aqueous samples. Although the criteria is identified for inorganic analytes only, this RPD criteria was adopted for comparison purposes only for both the organic compounds and inorganic analytes alike.

For the surface soils and sediments, nine duplicate samples and five triplicate samples were collected and analyzed. For the subsurface soil samples, eight duplicate samples and two triplicate samples were collected and analyzed. One duplicate and triplicate sample was collected and analyzed for the groundwater monitoring well sampling. Table 1.15, Percentage of Duplicate and Triplicate Samples Outside of the Acceptable RPD Criteria, presents the percentage of duplicate and triplicate samples that did not meet the RPD acceptability criteria. The percentage of samples that did not meet this criteria is very low, showing good field and laboratory precision. Based upon the information presented in Table 1.15, the original and duplicate samples analyzed by the contract laboratory used for TEAD has slightly better RPD precision than the laboratory designated by the U.S. Army Corps of Engineers-Mobile District.

Table 1.14. Samples grouped by SDG or Project Number

Surface soils			
SDG BR650			
SS-OB-01	SS-OB-06	SS-OB-11	SS-OB-16
SS-OB-02	SS-OB-07	SS-OB-12	SS-OB-17
SS-OB-03	SS-OB-08	SS-OB-13	SS-OB-18
SS-OB-04	SS-OB-09	SS-OB-14	SS-OB-19
SS-OB-05	SS-OB-10	SS-OB-15	SS-OB-20
SDG BR651			
SS-OB-21	SS-OB-26	SS-OD-04	SS-OD-09
SS-OB-22	SS-OB-27	SS-OB-05	SS-OD-10
SS-OB-23	SS-OD-01	SS-OD-06	SS-OD-11
SS-OB-24	SS-OD-02	SS-OD-07	SS-OD-12
SS-OB-25	SS-OD-03	SS-OD-08	SS-OD-25
SDG BR652			
SS-BKG-01	SS-OD-14	SS-OD-19	SS-OD-24
SS-BKG-02	SS-OD-15	SS-OD-20	SS-OD-26
SS-BKG-03	SS-OD-16	SS-OD-21	SS-OD-27
SS-BKG-04	SS-OD-17	SS-OD-22	RB 01
SS-OD-13	SS-OD-18	SS-OD-23	RB-02
SDG BR653			
SD-BEW-01	SD-BEW-06	SD-BKG-09	SS-BZ-05
SD-BEW-02	SD-BKG-05	SS-BZ-01	SS-BZ-06
SD-BEW-03	SD-BEW-06	SS-BZ-02	SS-BZ-07
SD-BEW-04	SD-BEW-07	SS-BZ-03	SS-BZ-08
SD-BEW-05	SD-BEW-08	SS-BZ-04	SS-BZ-09
SDG BR654			
SD-BEW-07	SD-BEW-08	SD-BEW-9	

Table 1.14. (Continued)

Subsurface soils			
Project 057531			
SB-OD-1(2)	SB-OD-1(40)	SB-OD-2(30)	SB-OD-3(20)
SB-OD-1(5)	SB-OD-2(2)	SB-OD-2(40)	SB-OD-3(30)
SB-OD-1(10)	SB-OD-2(5)	SB-OD-2(2)	SB-OD-3(40)
SB-OD-1(20)	SB-OD-2(10)	SB-OD-3(5)	SB-OD-9(1)
SB-OD-1(30)	SB-OD-2(20)	SB-OD-3(10)	SB-OD-9(2)
Project 057594			
SB-OD-4(2)	SB-OD-4(40)	SB-OD-5(30)	SB-OD-6(20)
SB-OD-4(5)	SB-OD-5(2)	SB-OD-5(40)	SB-OD-6(30)
SB-OD-4(10)	SB-OD-5(5)	SB-OD-6(2)	SB-OD-6(40)
SB-OD-4(20)	SB-OD-5(10)	SB-OD-6(5)	SB-OD-9(3)
SB-OD-4(30)	SB-OD-5(20)	SB-OD-6(10)	SB-OD-9(4)
Project 057595			
SB-OD-7(2)	SB-OD-7(30)	SB-OD-8(10)	SB-OD-9(5)
SB-OD-7(5)	SB-OD-7(40)	SB-OD-8(20)	RB-1-101997
SB-OD-7(10)	SB-OD-8(2)	SB-OD-8(30)	
SB-OD-7(20)	SB-OD-8(5)	SB-OD-8(40)	
Project 057620			
SB-BKG-1(2)	SB-BKG-1(30)	SB-BKG-2(10)	SB-BKG-5(1)
SB-BKG-1(5)	SB-BKG-1(40)	SB-BKG-2(20)	SB-BKG-5(2)
SB-BKG-1(10)	SB-BKG-2(2)	SB-BKG-2(30)	RB-2-102197
SB-BKG-1(20)	SB-BKG-2(5)	SB-BKG-2(40)	
Project 057643			
SB-BKG-3(2)	SB-BKG-3(30)	SB-BKG-4(10)	SB-BKG-5(3)
SB-BKG-3(5)	SB-BKG-3(40)	SB-BKG-4(20)	RB-3-102297
SB-BKG-3(10)	SB-BKG-4(2)	SB-BKG-4(30)	
SB-BKG-3(20)	SB-BKG-4(5)	SB-BKG-4(40)	
Groundwater monitoring wells			
Project 058927			
GW-01	GW-02		

Table 1.15. Percentage of duplicate and triplicate samples outside of the acceptable RPD criteria

Sample type	RPDs >50%/30% - total duplicates	RPDs >50%/30% - duplicates associated with triplicates	RPDs >50%/30% - triplicates
Surface soils and sediments	6.2%	7.6%	9.4%
Subsurface soils	2.0%	4.0%	5.5%
Groundwater monitoring wells	2.0%	2.0%	4.0%

Only data for the first round of groundwater sampling have been validated at this time. The validated groundwater data for all four sampling rounds of the baseline sampling program will be submitted when four quantities of sampling are available.

1.4.4 Coefficient of Variability for Surface Soils

The primary program objective of the OB/OD baseline site investigation has been to characterize average contamination levels in order to define a source term input for contamination migration modeling to assess potential off-site impacts. The sampling strategy for surface soils has been based on an adaptation of EPA soil screening guidance (U.S. EPA, April 1996) to TEAD. Commensurate with the goal of characterizing average contamination levels for migration modeling, composite surface soil samples were collected.

The numbers of composite surface soil samples eight (8) and specimens six (6) per composite for each sampling/exposure zone were selected to be statistically significant based on the Soil Screening Guidance: User’s Guide (U.S. EPA, April 1996) and Soil Screening Guidance: Technical Background Document (U.S. EPA, May 1996). Specifically, TEAD Phase II RFI soil sampling results were used to evaluate the coefficient of variability (CV) for each of the metal and energetic chemicals with analytical results. A CV of 4.0 was selected to represent the RFI data. The CV is defined as the standard deviation divided by the mean of all discrete (uncomposited) samples.

This selection was based on a data quality objective for TEAD of a Type I error of 0.10 or less and a Type II error of 0.40. Therefore, based on the Soil Screening Guidance, the selection of eight composite samples (with six specimens per composite) corresponds with a Type I error of 0.06 and a Type II error of 0.40. A Type I error (as defined in the Soil Screening Guidance for the Max test) is the probability of incorrectly concluding that a screening health criterion has not been exceeded when the exposure area mean is actually twice the screening criterion. A Type II error is the probability of incorrectly concluding that a screening health criterion for a contaminant has been exceeded when actually the exposure area mean is only half of the screening level.

Available TEAD surface soil sampling results from the OB/OD baseline sampling program have been used to calculate CV values for each target analyte for each sampling zone. These results are summarized in Table 1.16. There were only four exceedances of the CV=4 data quality goal:

- Lead: OB source zone (CV=6.04)
- Di-n-butyl phthalate: OB impact zone (CV=4.86)
- 2,4,6-TNT: OD operations zone (CV=6.02)
- Lead: OD input zone (CV=6.12)

The CV values for other analyte/sampling zones were generally substantially below 4.0 for all other surface sampling results.

Table 1.16. Summary of coefficient of variability (CV) for TEAD surface soils (unitless)

Chemical	OB				OD				
	Background zone	Source zone	Operations zone	Impact zone	Source zone	Operations zone	Impact zone	Sediments zone	Boundary zone
Metals	0.08-1.08	0.27-3.93	0.36-6.04 ^a	0.09-2.20	0.12-2.70	0.32-1.64	0.02-6.12 ^b	0.13-1.89	0.09-0.59
Energetics	ND	0.29-3.79	0.14-2.21	0.61-1.67	1.07-1.94	1.01-6.02 ^c	1.05-1.14	ND	ND
Semivolatiles	0.01-0.07	0.79-2.93	1.34-2.51	0.99-4.86 ^d	0.10-3.98	0.12-1.82	0.02-0.09	2.62	0.16
Cyanide	ND	0.54	0.24	ND	1.68	0.16	ND	ND	ND

ND = Not detected.

^aCV=6.04 was for lead. The highest CV was 1.55 for the OB source zone.

^bCV=6.12 was for lead. The next highest CV was 3.83 for the OD impact zone.

^cCV=6.02 was for 2,4,6-TNT. The next highest CV was 1.64 for the OD operations zone.

^dCV=4.86 was for di-n-butyl phthalate. The next highest CV was 1.99 for the OB impact zone.

Lead and 2,4,6-TNT have been identified as contaminants of potential concern (COPCs) for the surface soil as discussed in Sect. 1.6. A screening criterion is not available for di-n-butylphthalate. The Max test criterion as presented in the Soil Screening Guidance (U.S. EPA, May 1996) was used to further evaluate the representativeness of the surface soil samples with CV values greater than 4. These results are summarized in Table 1.17. Based on the Max test, if the maximum composite value from the sampling zone is less than twice the screening level, the sample size is considered to be adequate. Based on this criterion, only lead for the OB source zone did not meet this Max test criterion.

Table 1.17. Max test evaluation for samples with a CV of greater than 4

Chemical	Sampling zone	Max. sample concentration	Industrial		Residential	
			Screening level 2 (SL)	Max. less than 2 (SL)	Screening level 2 (SL)	Max. less than 2 (SL)
Lead	OB source	2,500 mg/kg	2,000 mg/kg	No	800 mg/kg	No
Di-n-butylphthalate	OD impact	17 mg/kg	NA	NA	NA	NA
2,4,6-TNT	OD operations	18 mg/kg	100 mg/kg	Yes	30 mg/kg	Yes
Lead	OD impact	533 mg/kg	2,000 mg/kg	Yes	80 mg/kg	Yes

NA = Not available or not applicable.

SL = Screening level.

A summary of average surface soil sampling results for lead is presented in Table 1.18. These data indicate that the highest lead surface soil concentration occurs at the OB source zone. The

CV+6.04 indicates quite a variability of lead concentrations in the immediate area of the burn pans. Since the sampling area for the OB source zone was limited to 1m around each of the burn pans, the high variability of lead sampling results is understandable. The high variability of the sampling results for lead will not significantly affect risk assessment and potential off-site contamination migration results presented in Attachment 26-OB/OD Risk Assessment and Management of the permit.

Table 1.18. Summary of average surface soil lead concentrations, mg/kg

Background zone	OB			OD			Sediments zone	Boundary zone
	Source zone	Operations zone	Impact zone	Source Zone	Operations zone	Impact zone		
30	1,768	400	94	24	16	84	14	29

1.5. HYDROGEOLOGICAL CHARACTERIZATION

1.5.1 Regional and Site-Specific Geology

TEAD is located on alluvial fan and lake terrace deposits representing alternating periods of submergence by Pleistocene Lake Bonneville. The area is bounded by Basin and Range block-faulted mountains on three sides. The valley is bounded on the west by the Stansbury Mountains, on the east by the Oquirrh Mountains, on the south by South Mountain, and on the north by the Great Salt Lake. The oldest rocks in the area are Cambrian Age quartzites exposed in the Stansbury Mountains. The remaining core of the Stansbury and Oquirrh Mountains consists of limestone and dolomite of late-Paleozoic Age and Tertiary (Oligocene) intrusive igneous and volcanic tuffs. Gravity surveys indicate that many faults are present in the bedrock beneath the valley.

Tooele Valley is filled with a thick sequence of unconsolidated sediments of Tertiary and Quaternary Age. The older Tertiary sediments comprise the Salt Lake Group and consist of moderately consolidated sand, gravel, silt, and clay with an abundance of volcanic ash. The younger Quaternary sediments consist of interlayered and unconsolidated sand, gravel, silt, and clay deposited before, during, and after the existence of Lake Bonneville. The thickness of the valley sediments ranges from a few feet at the margins of the valley to over 8,000 feet in the north central part of the valley. The contact between Tertiary and Quaternary sediments was reported to be between 800 and 900 feet bgs (JMM, 1993).

Bedrock beneath the unconsolidated sediments of the Tooele Valley consists of alternating quartzite and limestone beds similar to the late Paleozoic rocks found in the surrounding mountains. Geophysical surveys were conducted over the entire TEAD since little bedrock is exposed. Depth to bedrock interpretations were drawn based on a geophysical survey conducted by ERTEC in 1982. In the vicinity of the OB/OD Unit, the contoured map of bedrock is shown steeply dipping to the southeast with depths ranging from 250 to 1250 feet across the area. The monitoring well (MW-1) drilled to 800 feet bgs did not encounter bedrock (Appendix B).

1.5.1.1 Soils

TEAD is located on coalescing alluvial fan (bajada) and lake terrace deposits representing alternating periods of submergence by Pleistocene Lake Bonneville. Surface and near-surface soil characteristics reflect the topographic location and the geologic materials from which they were formed. The topography is characterized by gently sloping surfaces dissected by a series of intermittent (ephemeral) stream channels (e.g., Box Elder Wash at the OB/OD Unit). The soils consist primarily of gravelly loam, loam, or fine sand that developed on alluvial and/or lacustrine deposits. Soils that develop in semi-arid climates do not develop strong diagnostic horizons. In general, these soils are deep, well-drained, moderately permeable, and alkaline (i.e., pH greater than 7.0).

The OB/OD Unit is located primarily on Hiko-Peak series (HCD) with the surrounding ridges consisting of the Berent Hiko-Peak series complex (RGF). The Hiko-Peak series developed in alluvium from mixed rock types. They are located on fan terraces at elevations of 4,400 to 6,000 feet above mean sea level and consist of a gravelly loam to very gravelly loam with a pH of 7.9 to 9.0. Permeability is moderately rapid with an infiltration rate of 1.4×10^{-3} cm/sec to 4.2×10^{-3} . The background sampling area was purposely located in the same soil type. However, both these soil types contain inclusions of other soil types and are either intermingled or too small to map independently. This may be reflected in the variability of the metals concentrations observed in the analytical results (Sect. 1.5).

The soils in the region of the Boundary Zone sampling exposure area consisted of a different type similar to what is seen in the vicinity of Grantsville. These soils are the Taylorsflat series (TKC), characterized by a finer-grained loam with moderately slow permeability and infiltration rates from 1.4×10^{-4} cm/sec to 1.4×10^{-3} cm/sec (USSCS, 1991). A higher clay content here could account for slightly higher metals concentrations in general.

1.5.2 Regional and Site-Specific Hydrogeology

Regionally, groundwater originates at recharge areas along the basin margins, moves toward the north-northeast beneath Tooele Valley, and ascends to discharge areas in the central and northern parts of the valley. Most of the usable groundwater in the valley occurs in the alluvial fill deposits (Valley Fill Aquifer) and, to a lesser extent, in the underlying bedrock. Recharge zones along the valley margins extending into the basin are characterized by downward vertical gradients. Conditions vary throughout the valley with unconfined, confined, and artesian aquifers encountered.

Groundwater flow enters TEAD from the southwest, south, and southeast to converge beneath the central part of the site. The general direction of groundwater flow in the Valley Fill Aquifer is from south to north. Overall, the potentiometric surface is relatively flat across the TEAD, with an average hydraulic gradient of 0.007 ft./ft., except around bedrock highs. The average horizontal hydraulic conductivity is approximately 1,500 gpd/ft², whereas the average vertical hydraulic conductivity is approximately 225 gpd/ft². Because of the heterogeneity of the alluvial aquifer, calculated groundwater velocities range from about 4 feet/year to 9,800 feet/year.

TEAD Well #4, located 1.5 miles due north of the demo pits and burn pan area, was completed at a total depth of 780 feet bgs and is the closest production (or effective monitoring well) to the OB/OD Unit. Based on similar surface elevations, likely topographical influence, existing potentiometric maps, and assuming the same subsurface conditions as encountered in the production well, the expected groundwater flow direction in the vicinity of the unit is to the southeast. The Stansbury Marginal Fault runs along the mountain edge and is approximately 5 miles west of both the OB/OD Unit and TEAD Well #4. This fault acts as a divide between the alluvial formation and the bedrock and also serves as a no-flux boundary (Terracon, 1997). The nearest off-site water supply well is approximately 5 miles from the OB/OD Unit, north of the TEAD boundary.

1.5.3 Requirements for Groundwater Monitoring

Site-specific geologic characteristics and regional climatic conditions indicate that the potential for migration of contaminants from the shallow soils to the uppermost aquifer is insignificant. Although shallow soil contamination was identified at the site during the RFI, several factors indicate that there is a low potential for leaching of contaminants to the subsurface. The climate of Tooele Valley is semi-arid, and evaporation potential exceeds precipitation by more than a factor of 2.

A dry well (N6) was installed in 1982 immediately east of the OB/OD Unit. This boring encountered mostly sands and gravel with a “sandy-clayey silt” zone identified between 146 and 193 feet bgs. The boring was completed to a total depth of 709 feet bgs. The groundwater elevation in well N-6 was measured in June 1992 during the RFI, and the well was reportedly dry.

Based on the considerations summarized above and further presented in a TEAD position document dated November 1996, an exemption from the groundwater monitoring requirement (including an exemption from installing exploratory wells) was requested. Following review of the TEAD position on groundwater monitoring at the OB/OD Unit, the UDEQ indicated in a letter dated January 17, 1997, that additional hydrogeological data were required. Therefore, drilling and completion of one exploratory groundwater well was agreed upon to further characterize the hydrogeology at the OB/OD Unit. The letter also stated that the application of a direct measurement technique (i.e., use of a colloidal borescope) would provide an estimate of groundwater flow rate and direction based on the completion of the one well.

1.5.4 Groundwater Monitoring

As a result of the above requirements, one exploratory groundwater well was installed to further characterize the hydrogeology at the OB/OD Unit. Details on the construction of the well (MW-1) are included in Sect. 1.2.3.1. Subsequent to the successful completion of a monitoring well, planned quarterly sampling rounds have been initiated. Results from the first two rounds are included in Appendix D. It should be noted that the initial sampling event was conducted prior to installing the dedicated pump system, and the bailer method that was used did not collect as representative a sample as subsequent sampling events.

In addition to the water quality data obtained, the colloidal borescope results indicated further characterization of groundwater flow velocity. Three test zones monitored in the upper screen interval (720-730 feet bgs) yielded reliable directional flow data. All three zones showed a consistent flow direction to the south-southwest, with a south-southeast component at 729 feet bgs. The average groundwater seepage velocity (corrected for borehole influence) is 10 feet/day. The flow direction is consistent with the site topography; based on results of the investigation, it appears that the present monitoring well location is adequate to determine if contamination is impacting the groundwater. The entire colloidal borescope report by ORNL-GJ (including computer plots) is included in Appendix D.

1.6. Contaminants of Potential Concern

The validated data set from the TEAD baseline OB/OD sampling program and conservative health impact screening criteria have been used to identify COPCs. A COPC does not necessarily indicate an unacceptable health impact. These COPCs, however, have been further evaluated in the human health risk assessment included in Attachment 26 - OB/OD Risk Assessment and Management of the Permit. Contaminants of potential ecological concern are identified in Attachment 26.

The validated data set has been summarized and processed to determine COPCs for each sampling medium. These electronic files are provided in Appendix I. A value of 0.5 of the analytical PQL was assumed if there were detection values for other samples in the same medium and sampling zone. Otherwise, the concentration was assumed to be zero for data processing purposes.

The U.S. Environmental Protection Agency (EPA) Region IX preliminary remediation goals (PRGs) for each medium were used as human health screening criteria to select COPCs (U.S. EPA, May 1998). In addition to PRGs, Region IX soil screening levels were also used to evaluate migration potential to groundwater for COPCs. A Hazard Quotient (HQ) was calculated for each sampling target analyte as follows:

$$HQ = \frac{CS}{SL} \quad \text{Eq. 1.6-1}$$

where:

- HQ= Hazard Quotient (unitless)
- CS = Concentration of Sample
- SL = Screening Level for Human Health Impacts

An HQ value of greater than one indicates the potential for a health impact.

Two sets of COPCs were identified for each sampling medium/zone combination. The first set was based on industrial PRGs and the second on residential PRGs. The industrial screening criteria can be used to characterize current on-site land use conditions. Residential screening

criteria were conservatively used to identify chemicals to be evaluated in the human health risk assessment.

COPCs were defined as validated sampling concentration results above the detection level (PQL) with an HQ greater than or equal to 0.1 (to conservatively account for potential chemical additivity effects). For metals, in addition to the preceding criteria, the sampling results must be considered statistically significant compared to background. Results are considered statistically significant if they are greater than the sum of the average background concentration plus twice the standard deviation.

Summary tables of COPCs (and associated concentrations and HQ values) are provided in Appendix G, based on industrial as well as residential screening criteria.

1.6.1. Surface Soil COPCs

A summary of surface soil COPCs and associated HQ values (based on industrial screening criteria) are presented in Table 1.19. Aluminum, arsenic, chromium (total), and lead were the only metal COPCs identified. However, aluminum, arsenic, and chromium were not detected at elevated levels at the OB/OD Unit although concentrations were higher within the background as well as boundary zones. Therefore, aluminum, arsenic, and chromium are only considered to be tentative industrial COPCs. RDX is the only energetic identified as an industrial COPC. Hexachlorobenzene was the only semivolatile identified as an industrial COPC. Surface soil concentrations of chromium also exceeded one tenth of the U.S. EPA Region IX screening levels (U.S. EPA, May 1998) considering potential infiltration to groundwater (based on generic hydrogeological conditions). TEAD utilizes appropriate personal protection equipment to mitigate potential exposure to on-site workers at the OB/OD Unit.

An expanded list of surface soil COPCs based on residential screening criteria is presented in Table 1.20. This COPC list consists of six metals, two energetics, and seven semivolatiles. However, aluminum, arsenic, and chromium were not detected at elevated levels at the OB/OD Unit although they were at higher concentrations within the background and boundary zones. Higher concentrations at the boundary zone may be attributed to the different type of soil at that zone which is expected to have a higher mineral content compared to the OB/OD permit. Therefore, aluminum, arsenic, and chromium are only considered to be “tentative” residential COPCs. Currently residential criteria are not applicable to the on-site sampling zones although they have been used to identify conservative inputs to the risk assessment. Surface soil concentrations of calcium and chromium, also exceeded one tenth of the U.S. EPA Region IX screening levels (U.S. EPA, May 1998) based on potential infiltration considerations.

1.6.2. Subsurface COPCs

A summary of subsurface soil COPCs based on industrial screening criteria is presented in Table 1.21. These COPCs are applicable only to on-site workers potentially exposed to subsurface soils (e.g., during pit excavation operations) at the OB/OD Unit. TEAD uses personal protection equipment to mitigate potential worker exposure. The list of subsurface COPCs is limited to arsenic, beryllium, cadmium, chromium, and the energetic RDX. These results are applicable

only to the OD source zones associated with the detonation pits. Subsurface soil concentrations of arsenic, cadmium, and chromium exceeded one tenth of the U.S. EPA Region IX levels (U.S. EPA, May 1998) based on potential infiltration groundwater considerations.

The residential subsurface COPCs summary is provided in Table 1.22. The COPC list is the same as for the industrial list except that the energetic TNT is an addition. Some COPCs were detected at screening levels to a depth of 40 feet. These depths are assumed to be associated with pit depths associated with subsurface detonations. Also, there is a potential for relatively high background levels due to the prevalence of mineral deposits in the region. Currently, residential criteria are not applicable to the on-site sampling zones although they have been used to identify conservative modeling inputs for risk assessment purposes. Subsurface concentrations of arsenic, cadmium, and chromium also exceeded one tenth of the U.S. EPA Region IX screening levels (U.S. EPA, May 1998) based on the potential for infiltration to groundwater based on generic hydrogeological conditions.

1.6.3 Groundwater COPCs

Candidate groundwater COPCs are listed in Tables 1.23 and 1.24 based on industrial and residential screening criteria, respectively (U.S. EPA, May 1998). Only lead, zinc, and bis(2-ethylhexyl) phthalate were identified as candidate groundwater COPCs. However, there were no COPCs based on the second round of sampling. The first round of sampling may not be representative due to sampling limitations as discussed in Sect. 1.2. Therefore, only the sampling results from the second round were used as input to the risk assessment. These results will be reevaluated after four rounds of sampling results are available.

Table 1.23. Groundwater COPC summary, industrial screening levels

COPCs	Hazard Quotient (HQ)			
	1 st Quarter		2 nd Quarter ^a	
	Primary	Duplicate	Primary	Duplicate
Metals				
(Lead) ^b	(1.16)	(1.38)		
(Zinc) ^b	(0.15)	(0.17)		
Semivolatiles				
(Bis(2-ethylhexyl)phthalate) ^b	(0.24)	(0.21)		

^aAll HQ values for the 2nd round of sampling were less than 0.1. The only detects for the 2nd round were barium and sodium.

^b() = Not considered as an industrial COPC for groundwater since round 1 results may not be reliable due to sampling problems and round 2 results do not justify selection as COPCs.

Table 1.19

Table 1 .20

Table 1.21

Table 1.22

Table 1.24. Groundwater COPC summary, residential screening levels

COPCs	Hazard quotient (HQ)			
	1 st Quarter		2 nd Quarter ^a	
	Primary	Duplicate	Primary	Duplicate
Metals				
(Lead) ^b	(2.90)	(3.45)		
(Zinc) ^b	(0.66)	(0.75)		
Semivolatiles				
(Bis(2-ethylhexyl)phthalate) ^b	(1.04)	(0.90)		

^aAll HQ values for the 2nd round of sampling were less than 0.1. The only detects for the 2nd round were barium and sodium.

^b() = Not considered as a residential COPC for groundwater since round 1 results may not be reliable due to sampling problems and round 2 results do not justify selection as COPCs.

2.0. ROUTINE MONITORING PROGRAM

The routine monitoring program will be conducted for the OB/OD Unit at TEAD based on results of the baseline-sampling program and associated risk assessment. The sampling locations and procedures will also be based on the baseline program as discussed in Sect. 1 and the SAP (U.S. Army, June 1997a).

2.1. SURFACE SOILS AND SEDIMENTS - ROUTINE MONITORING

Surface soils and sediments will be sampled for contaminants of concern (COCs) based on results of the baseline risk assessment as included in Attachment 26 to the Permit. The sampling frequency will be once every 5 years commensurate with the Permit renewal period and sampling risk assessment result, which indicates that soil exposure impacts off site (attributed to OB/OD operations) would be minimal.

2.2. SUBSURFACE SOILS - ROUTINE MONITORINGS

Subsurface soil sampling will not be included in the routine OB/OD monitoring program. Available groundwater sampling results and the baseline risk assessment have demonstrated that potential for migration of the OB/OD contaminants to the groundwater is insignificant. Based on current land use of the OB/OD, the public is restricted. Therefore, there is no current exposure pathway for subsurface soils applicable to off-site receptors.

2.3 GROUNDWATER - ROUTINE MONITORING

Groundwater will be sampled for COCs based on the baseline sampling results and risk assessment. The sampling frequency will be once every 5 years commensurate with the Permit renewal period. This approach is adequate considering the lack of groundwater COPCs (after over 40 years of OB/OD operations) based on available sampling data and expected slow infiltration rates from the OB/OD Unit.

2.4. SURFACE WATER AND WETLANDS - ROUTINE MONITORING

Surface water sampling will not be included in the TEAD OB/OD impact areas. The nearest surface water drainage is Box Elder Wash. Sediment sampling will be conducted as part of the surface soils monitoring program.

3.0. REFERENCES

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APPENDICES

APPENDIX A

**TNT SCREENING SAMPLE
RESULTS - SURFACE SOILS**

APPENDIX B

MONITORING WELL CONSTRUCTION LOG

APPENDIX C

MONITORING WELL LOCATION

APPENDIX D

COLLOIDAL BORESCOPE INVESTIGATION

APPENDIX E
INDICATOR PARAMETER RESULTS FROM
MONITORING WELL

APPENDIX F
BASELINE SAMPLING PROGRAM
QA DATA

APPENDIX G

COPC SUMMARY TABLES

APPENDIX H

**BASELINE SAMPLING PROGRAM VALIDATED DATABASE
(ELECTRONIC DATA FILE)**

APPENDIX I

**COPC SELECTION PROCESS
(ELECTRONIC FILES)**